Executive Summary

Adaptive Environmental Management

Part 1 of this document describes a strategic approach to adaptive environmental management (AEM) for the Lower Columbia River (LCR) and estuary. Adaptive management prescribes an iterative management process wherein management activities can be changed in relation to their efficacy in restoring and/or maintaining an ecological system in some desired range of conditions. A key component in AEM is the establishment of a feedback mechanism whereby monitoring can be used in combination with an understanding of the ecosystem to alter management actions, if necessary, to obtain future system conditions compatible with the desired conditions and/or to avoid or minimize undesired effects.

Decisions made within the context of AEM are often based on incomplete data and imperfect scientific understanding. Importantly, AEM provides a decision-making process that can adjust management actions on the basis of newly acquired science and monitored responses of performance measures to previous management actions. This iterative process can increase the likelihood that management goals and objectives (e.g., ecosystem restoration, sustainability) will be achieved.

There are three ways to conduct adaptive environmental management: (1) evolutionary (trial and error), (2) passive adaptive, and (3) active adaptive management. Evolutionary AEM attempts to achieve desired conditions through educated guesses and accumulated knowledge of system response to previous management activities. Passive AEM modifies management actions in response to changes in monitored conditions observed over the "natural" range of managed perturbations to the system. Active AEM involves purposeful manipulations of the system to increase understanding of system behavior and to achieve management goals and objectives. Active AEM can involve trade-offs between short term gains in understanding that must be weighed against the probability that manipulations might produce undesired and irreversible changes in ecosystem conditions.

Fundamental to AEM is the specification of desired conditions for valued resources in the system(s) of interest. In complex and dynamic ecological systems, it may be more realistic to define the ranges (or distributions) of acceptable values for each system attribute. AEM can then operate to create and maintain similarity between the current and desired variability in system conditions.

The strategic Plan for AEM is designed to be consistent with the guidance provided in 65 Federal Register (FR) 35242. This FR document identifies specification of alternative management actions, addressing uncertainties, and the establishment of critical feedback mechanisms between monitoring results and subsequent management actions as necessary features of AEM. Based on 65 FR 35242 and items specified in the National Oceanic and Atmospheric Administration terms and conditions [National Marine Fisheries Service

(NMFS) 2005, 2002], this proposed AEM Plan emphasizes the following components: management goals and objectives, a management and decision-making process, identification of existing and proposed monitoring actions (MA), identification of models that may prove useful in assessing outcomes of management decisions, a methodology for examining uncertainties, opportunities for stakeholder input, and overall transparency of the AEM Process.

The vision implied in the proposed Channel Improvement AEM Plan emphasizes the direct management of potential physical-chemical impacts associated with channel deepening. Importantly, the proposed AEM Process can contribute to the development of a comprehensive adaptive management effort ultimately focused on enhancing the survival, growth, and ocean entry of juvenile salmonids that utilize the LCR and estuary.

Adaptive Management for the Channel Improvement Project

Part 2 of the report addresses the specific design and implementation of an AEM Plan and Process in support of the Columbia River Channel Improvement Project (CRCIP). Provisions for implementation are primarily based on the CRCIP, Final Supplemental Integrated Feasibility Report (FSIFR) and Environmental Impact Statement (EIS) (FSIFR/EIS, January 2003), the NMFS Biological Opinion (BO) (February 2005, May 2002), and the Section 401 Water Quality Certification issued by the Oregon Department of Environmental Quality and Washington Department of Ecology (June 2003). The primary purpose of the AEM Plan and its implementation is to manage the channel improvement project in an adaptive manner to avoid or minimize physical-chemical impacts in relation to channel deepening in the LCR and estuary. Adaptive management directed at habitat, food webs, ecological production, juvenile salmonids, and other species defines a second level of management to be pursued if channel deepening results in demonstrated impacts to the physical-chemical characteristics. Importantly, the AEM Process will evaluate the effectiveness of compliance measures, MA, and research to ensure that project construction, operation, and maintenance have impacts no greater than those described in the Biological Assessment or the BO (NMFS 2005, 2002).

The recommended plan (1999 FSIFR/EIS) indicated that dredging would be limited to selected areas from Columbia River mile (CRM) 3, near the mouth of the river, to CRM 106.5, near the I-5 Bridge in Portland. The revised study area includes the bank-to-bank run of the Columbia River from Bonneville Dam to the river mouth and extending in a fan shape 12 miles into the Pacific Ocean. The study area divides the run of the river into three reach types: riverine (Bonneville Dam to CRM 40), estuarine (~CRM 40 to CRM 3), and river mouth (CRM 3 to outer boundary of the Deep Water Site). The study area also includes sites for upland disposal or dredged materials, ecosystem restoration, and wildlife mitigation.

The proposed Channel Improvement AEM Process will focus on short- and mid-term management actions and system responses. The MA will include two years of measurements prior to construction, two years during construction, and a third year following the end of construction. The periods of pre-construction and construction correspond to the near- (0–5 years) and mid-term (5–10 years) timeframes identified in the BO (NMFS 2005, 2002). Emphasis will be on near-term physical impacts of channel improvement. Mid-term management actions may include the use of monitoring and research results to establish mid-term trends in the physical aspects of the systems and potentially other resources of concern, depending on the results of the near-term system responses to channel improvements. The long-term actions include years 10 and beyond. At this scale, trend analysis could be used to assess ecosystem impacts of channel improvement.

The Adaptive Management Team

The organizational structure for the Project consists of the following: (1) the formal Adaptive Management Team (AMT), and (2) a less formal technical support group. The AMT comprises the managers, decision makers, and technical staff ultimately responsible for initiating, carrying out, and sustaining the AEM Process. The organizational structure also encourages interactions with the scientific and technical community, as well as concerned stakeholders.

The AMT technical support group serves as a primary source of technical support to the AMT. The group comprises professionals that primarily have other duties and responsibilities, but would be available as necessary to assist the AMT. The AMT can also establish subcommittees for the purposes of compiling information, performing analysis, discussing issues, and reporting to the AMT. Subcommittees would reasonably consist of physical and chemical oceanographers. Fisheries biologists, ecosystem scientists, environmental toxicologists, risk analysts, and hydrologic engineers could be consulted as needed.

To facilitate adaptive management, the AMT regularly receives information from the technical support group that describes current conditions and trends for selected Project performance measures or risk endpoints. Based on deliberations that may draw upon technical inputs of the support group, as well as advice solicited from the general scientific community and other appropriate sources, the AMT will recommend any necessary changes in the conduct of the Project in order to achieve and maintain the Project AEM goals and objectives.

Stakeholder Participation

The AEM process benefits from active participation by invested stakeholders. The AEM Plan underscores the key role played by the Corps of Engineers. The Plan also identifies federal (NMFS, USFWS) and state (Washington, Oregon) agencies, as well as the Sponsor Ports as principal partners in the AEM Process. The Tribes and interested public can also become actively involved in the Project’s adaptive management process (Appendix B). The nature of participation can be largely determined by the various responsibilities (e.g., legislative mandates), economic concerns, and public welfare interests of the stakeholders.

The important point is that the AEM Process is designed to be open and transparent in addressing the concerns of a broad base of Project stakeholders.

The risk-based decision framework for AEM provides for documentation of the management and decision-making process. The framework includes identification of the decision alternatives and criteria for selecting among management alternatives. The specific data, information, and model results used to support particular decisions will be recorded. The uncertainties associated with the sources of information entering into each decision analysis will be characterized along with an evaluation of the risks implied by each decision alternative. Documentation of the AEM Process and making this information readily available will further demonstrate the transparency of the process to stakeholders and the interested public. Documentation approved by the AMT will be posted on the CRCIP internet site (www.nwp.usace.army.mil/issues/CRCIP), which is configured to accept comments concerning various aspects of the Project.

CRCIP Adaptive Management Process

Seven steps outline the AEM Process for the Channel Improvement Project:

1. Results of the ongoing monitoring programs, ecosystem evaluation actions (EEA), and research are summarized and reported on a quarterly basis.

2. The results of monitoring programs, EEA, and relevant research are collated and analyzed by the technical support group.

3. The technical support group advises the AMT concerning any performance measures or risk endpoints that exceed the decision criteria.

4. If none of the decision criteria are exceeded, the AEM Process can simply continue with the current monitoring programs until the next evaluation is performed (i.e., Step 1).

5. If decision criteria are exceeded, the AMT requests the USACOE to develop a mitigation or management Plan intended to redress the Project impacts indicated by the monitoring results.

6. Based on the USACOE Plan, the AMT can recommend continuation of the current management practices or adaptations of current practices.

7. Following resolution of the AMT recommendations, the AEM Process continues by cycling back to step 1.

Performance Measures and Risk Endpoints

Performance measures define desirable ecosystem responses to management actions (e.g., dredging). Risk assessment endpoints define complementary undesirable ecosystem responses that might result from such actions. AEM is an iterative process that tracks changes in performance measures and risk endpoints and modifies management actions accordingly.

The principal Project performance measures or risk endpoints include changes to depth, temperature, and salinity. The underlying hypothesis is that the channel deepening will not significantly alter the physical or chemical conditions of the lower river and estuary. Potential Project impacts on sturgeon, smelt, and Dungeness crab are also of concern and are addressed in the AEM Plan.

Monitoring Actions and Decision Criteria

A credible monitoring program provides the necessary data to describe current conditions and outcomes of EEA undertaken as part of the Project. The monitoring effort is an essential component in developing the feedback between management actions and system response necessary for adaptive management. The necessary data will be provided by USACOE MA A-1 through MA-6.

Values of the performance measures/endpoints have been selected as initial decision criteria for use in implementation of the AEM Plan. (Appendix D details the development of these criteria). Comparisons of pre-project, construction, and post-construction data with the decision criteria will be used to evaluate Project impacts. Monitoring results that are at variance with the decision criteria can "trigger" adaptive management in accordance with the Plan. Importantly, the effectiveness of the decision criteria in supporting the AEM Process will be evaluated in relation to AEM goals and objectives during the Project. Criteria can be modified if they prove overly conducive to false positive or false negative assessments of Project impact.

The initial decision criteria for water depth, salinity, and temperature derive from statistical analysis of available CORIE monitoring data (1996–2004) and USACOE-sponsored MA-1. MA-1 will continue the monitoring for three CORIE stations: red26, grays, and cnbc3. The AMT will review newly collected monitoring data in relation to (1) a tabular summary of 20- and 80- percentiles of estimated monthly median values, (2) a similar table of 5- and 95-percentile values, and (3) for water temperature, plotted relationships between daily median temperatures for a reference location (woody) and the corresponding values for the three MA-1 stations.

MA-2 will provide annual dredging volumes associated with construction and operation of the 43-foot channel. Volumes will be reported for each dredging bar (~3-mile reaches). Volumes of dredged materials will be compared to projected values. This MA will continue through the Project duration. The decision criterion for dredging volume is whether or not actual volumes of dredged materials exceed the volumes proposed in development of the CRCRIP. The percent exceed will be determined by accuracy and precision associated with estimation of the volume of dredged materials. An initial exceedance value of 15% is under review by the AMT. In addition, adaptive management might be initiated if the volumes of dredged materials exceed the capacity for their disposal.

MA-3 will examine accretion and erosion in the main channel in relation to the channel deepening. Navigation channel surveys from CRM 3 to CRM 106 will be conducted annually (between December and February) for two years prior to construction, two years during construction, and three years after construction. The surveys will estimate minimum, maximum, mean and median depth across the channel, standard deviation and coefficients of variation will also be calculated. The consensus AMT decision criteria for MA-3 are defined as an "envelope" calculated as the minimum surveyed depth +1 standard deviation and the maximum depth +1 standard deviation. The envelope is defined across the channel for each survey with particular emphasis on the northern and southern boundaries of the navigation channel.

MA-4 will augment estuary habitat surveys being conducted by NMFS as part of the Anadromous Fish Evaluation Program. The surveys will be conducted three years after construction to determine if changes in habitat result from the channel deepening. The surveys will assess tidal marsh, swamp, flats, and deep-water habitats and will also address habitat complexity, connectivity, and conveyance. Habitat-specific food availability will be estimated along with the use of peripheral areas by juvenile salmonids. Threshold values that define unacceptable change (i.e., decision criteria) will be defined for each habitat type. Measured changes that exceed any of the decision criteria can trigger adaptive management.

MA-5 will review sediment chemistry data to evaluate the potential impacts of channel deepening on the exposure of aquatic organisms to toxic contaminants. MA-5 will ensure that channel construction and maintenance does not disturb undetected deposits of fine-grained material, potentially causing redistribution of contaminants that could pose a risk to species of concern. The AMT technical support group will annually review any new sediment chemistry from the LCR and estuary. The SEDQUAL database will play an important role in this continued review and evaluation. A new Sediment Evaluation Framework (SEF) is projected to be in place by September 2006. The SEF largely addresses the sediment contaminants of interest to Washington, Oregon, and Idaho. The decision criteria for MA-5 will be made based on the final SEF.

MA-6 addresses the potential impacts of channel improvements on fish stranding by commercial navigation on the lower river and estuary. The proposed decision criterion is based on a comparison of pre- and post-project numbers of stranded fish and associated estimates of the probability of fish stranding. An increase in the probability of fish stranding following channel improvements can initiate the adaptive components of the AEM Plan. In addition to potentially changing the frequency of fish stranding events, channel modifications might alter the susceptibility of different fish species to stranding. Susceptibility to stranding can also serve as decision criteria for fish stranding in the AEM Plan.

Sturgeon, Smelt, Dungeness Crab, Sediment

Decision criteria are being developed to assess potential impacts of channel modifications on sturgeon, smelt, and Dungeness crab. The decision criteria for these resources are defined mainly as administrative constraints defined by the states of Oregon and Washington. These criteria are evaluated in the AEM Process as issues of compliance rather than as flexible or adaptable criteria.

Criteria to protect sturgeon address the possible Project impacts on the mortality, movements, feeding behavior, and habitat utilization of these fish in relation to the dredging process and the disposal of dredged materials. The results of previous studies of monitored individual sturgeon suggest that the dredging process or the disposal of dredged materials does not measurably affect these fish. The derivation of decision criteria for sturgeon is continuing with the analysis of preferred habitats and the potential impacts of channel dredging on these habitats.

Decision criteria to minimize channel improvement impacts on smelt (Eulachon) take the form of depth constraints (43 ft.) on flow lane disposal for specified river miles (e.g., between CRM 35 and CRM 75). Particular attention will be paid to in-water disposal, which is not permitted between the eighth and 20th weeks of the year (out migration) throughout CRM 35-75. In-water disposal of dredged material will not occur in areas shallower than 43-feet between CRM 35 and CRM 75 along the Washington shoreline. Depths determined in the pre-construction bank-to-bank bathymetry data supplemented by additional channel bathymetry measures define these areas. If in-water disposal is essential during the period of peak out migration, then the Corps shall further study the potential for smelt losses as a result of dredged material disposal impacts. Appropriate mitigation measures shall be developed based on the study outcomes as part of the adaptive management process.

The objectives of the AEM Plan concerning Dungeness crab are to avoid or minimize crab entrainment mortality and crab burial by disposal of dredged materials. Field studies were undertaken from 2002 through 2004 to estimate the numbers of crab entrained and killed by the dredging process, and to develop a model that predicts crab distribution as a function of salinity in the estuary. Entrainment studies were performed at the mouth of the Columbia River, Desdemona Shoals, Upper Sands, Miller Sands, and Flavel Bar. Estimates of entrainment rates and projected volumes of construction dredging were used to estimate numbers of entrained crabs. These entrainment mortalities were extrapolated to an expected number of lost future adults and losses to the crab fishery. These results will be used as AEM decision criteria to assess crab entrainment in relation to channel modifications. The salinity model identifies 16 practical salinity units (psu) as the value below which crab abundance markedly decreases. Characterization of the spatial-temporal distribution of water >16 psu can be used to estimates crab abundance throughout the estuary. The salinity model can be used to estimate the implications of alterations in salinity attributed to channel modifications on the distribution of crab. The model can complement MA aimed at assessing entrainment of crabs during dredging, as well as potential burial of crabs by flowlane disposal of dredged materials.

Concerns have been expressed by the AMT about the potential for the disposal of Project dredged materials to impact valued coastal zone habitats. To address these concerns, the Corps is pursuing a regional sediment management program that encompasses the Channel Improvement Project and other Columbia River navigation projects. Consistent with this sediment management program, higher priority will be given to development of near shore sites where disposal of dredged materials can effectively contribute to the littoral zone sediment budget. Accordingly, when near shore sites are available, they will be given priority over estuarine in-water disposal and deepwater ocean disposal to minimize potential dredged material disposal impacts to coastal zone resources.

Ecosystem Evaluation Actions

The results of six EEA (EEA-1 through EEA-6) can provide useful information in support of the AEM Process. These evaluation actions were developed to further assist the Corps, NMFS, and the USFWS in advancing the basic understanding of the LCR ecosystem. In general, the evaluation actions will address indicators of the salmonid conceptual model and advance the knowledge base for conservation and recovery of salmonid species. Several actions will provide quantitative information describing habitat parameters including bathymetric information for listed evolutionary significant units. The corresponding studies will focus on tidal marsh, shallow water flats, and water column habitat. Other evaluation actions derive from concerns of sublethal effects of contaminants on fish growth, disease and resistance, for juvenile salmonids and their prey. The individual EEA include:

- EEA-1 will generate additional information on salmonid habitat distribution in the estuary. Transects will be surveyed and analyzed in a manner similar to NMFS studies currently underway to characterize salmonid habitat utilization. Data will be obtained prior to construction and three years after Project completion.

- EEA-2 will ascertain the use of tidal marsh habitat by cutthroat trout. Juveniles of this species develop in the estuary for extended periods of time compared to other anadromous fish. In addition to previous efforts, more data will be collected for one year of prior to construction and for two years of following construction.

- EEA-3 includes a bank-to-bank hydrographic survey of the estuary. The survey will provide valuable information describing the bathymetry of the estuary and shallow water-flat habitat.

- EEA-4 addresses contaminant issues in juvenile salmonids and their prey. One year of preconstruction data will be collected. Additional contaminant data will be collected during construction and three years following construction.

- EEA-5 will assess the possible sublethal impacts of contaminants on juvenile salmonid growth and survival.

- EEA-6 centers around an "Estuary Turbidity Maximum Workshop." The purpose of the workshop is to increase understanding of the estuary turbidity maximum (ETM) and develop effective management actions to conserve the ETM.

Data produced by these actions will be collated and provided to the AMT to (1) determine the possible need for alteration of the Project actions (i.e., dredging), and (2) assess the value of information provided by the actions in relation to management and decision making. Importantly, the results of these studies may assist in the analysis and interpretation of monitoring data. These studies might also provide critical information for the development and implementation of environmental/ecological models used in support of adaptive management.

Uncertainty

The proposed AEM Plan is an example of risk-based decision making or decision making under uncertainty. Risk-based decision making takes into account the uncertainties that arise from natural variability and imperfect knowledge. Uncertainty can confound the decision-making process by eroding confidence in accurately selecting among alternative management actions.

Sources of uncertainty fall into three broad categories: natural variability, knowledge uncertainty, and decision model uncertainty. Natural variability refers to the inhomogeneous properties of natural materials, such as soils and sediments, and the range and relative frequency of events, such as rainfall or stream flow. Managers can minimize the effect of uncertainty by recognizing the presence of natural variability in ecosystems and defining management objectives probabilistically, as risk endpoints. Gathering more and better information cannot reduce natural variability.

Knowledge uncertainty reflects deficiencies in understanding of ecosystems and factors that affect them. If knowledge uncertainty is high, it might not be possible to distinguish the effect of one management alternative from another with an acceptable degree of certainty. Gathering more information and better data can reduce knowledge uncertainty.

Uncertainties associated with management and decision-making should be identified and characterized. The implications of these uncertainties on projected decision outcomes and risks should be quantified. The expected effects of channel improvement on achieving desired ecosystem conditions or incurring risks of adverse impacts will be estimated using relationships between the variables manipulated through management actions and the selected performance measures and assessment endpoints. Each of the manipulated variables is a source of uncertainty. These uncertainties, along with natural variability will be described, quantified, and where possible used to estimate decision outcomes and risk.

Comprehensive Adaptive Management in the Lower Columbia River

The proposed AEM Plan is designed to focus initially on potential physical-chemical impacts of channel deepening. It is also recognized that these attributes, while of fundamental environmental importance, represent a subset of the components of a more comprehensive conceptual model of the lower river and estuary. The CRCIP AEM Plan can contribute valuably to the future development and integration of a comprehensive adaptive management plan for the LCR and estuary. Data and information generated by the MA, EEA, and research performed during the course of Project management can be shared among other agencies and stakeholder groups involved in other AEM Projects. This sharing can help in the development of a more comprehensive ecological understanding of the river and estuary ecosystem. Cooperation among ongoing (and future) AEM Projects will be required to achieve the desired goals concerning recovery and sustainability of the valued salmonid resources in the LCR and estuary.